CHEMICALS

Project Fact Sheet

Enhanced Heat Exchangers for Process Heaters

Benefits

- Energy savings of 16.9 trillion Btu per year
- 1,060 tons less NOx emissions per year
- 312 tons less CO emissions per year

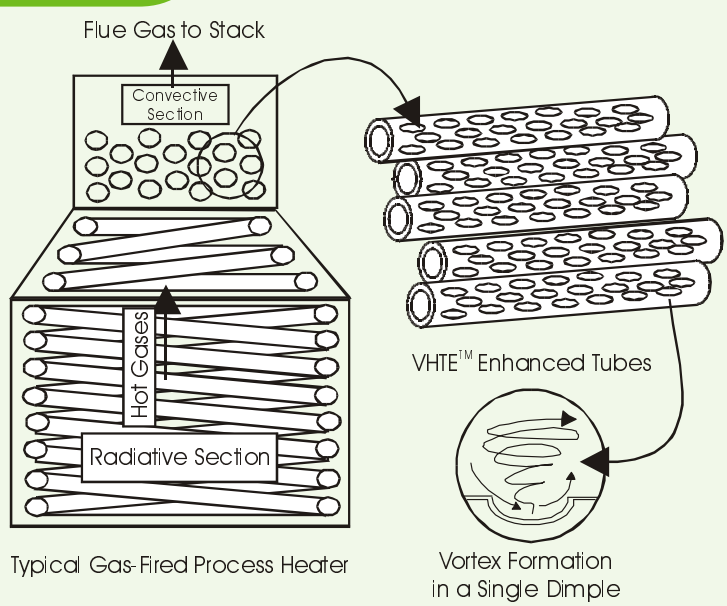
Applications

Dimpled tube technology can be applied to convective sections of gas-fired, high-temperature (1,500°F to 2,000°F fire box temperatures) process heaters. The benefits noted above are based on application to the approximately 700 high temperature process heaters being operated in the chemical industry

Dimpled Tubes will Significantly Increase Heat Transfer Rate

The use of dimpled tube technology (Vortex Heat Transfer Enhancement or VHTE™) in convective sections of commercial high temperature heaters has the potential to substantially improve energy efficiency and cost effectiveness in process heating industry-wide. In dimpled tube technology, spherical cavities are arranged on the outer surface of the convective section tube. Each dimple works as a "vortex generator" that intensifies the rate of convective heat transfer between the dimpled surface and the gas flowing over the surface. Multiple laboratory evaluations have shown that the use of dimpled tubes increases the heat transfer coefficient by over 30% compared with bare tubes and has the potential for decreasing fouling deposition rate compared with extended surface tubes. Applying dimpled tubes also improves heater thermal efficiency by as much as 5% without any significant increase in system draft loss and decreases CO, NO_x and unburned hydrocarbon emissions. To promote widespread acceptance of this technology, commercial demonstration is needed. If this technology were applied to high temperature process heaters industry-wide, the energy savings would amount to 16.9 trillion Btu per year.

Enhanced Heat Exchanger



Dimpled-tube technology intensifies convective heat transfer and has the potential for reducing fouling deposition.

Project Description

Goal: To develop and demonstrate a cost-effective dimpled tube technology for significantly improving the energy efficiency of fired process heaters while reducing fouling rates.

The convective sections of fired process heaters transfer sensible heat from the combustion products to the process fluid. The feedstock is then additionally heated in the radiative section of the heater. Unlike other approaches to increase heat transfer rates in the convective section of these heaters, dimpled tube technology will not increase the pressure drop across the bank of convective section tubes. Due to the vortex structures developed on the enhanced surface, a reduction in the fouling rate on that surface is expected. Computational Fluid Dynamics (CFD) modeling has demonstrated the existence of stable three-dimensional vortices in the dimples, as well as the internal structure of the vortex inside a single cavity. Dimpled tube technology can be easily applied to the outer surface of the 1.5-inch to 7-inch diameter tubes that are typically specified for short-residence time and long-residence time convective sections.

Progress & Milestones

The key milestones for this project are:

- Design, fabricate and evaluate selected dimpled tube configurations and surface profile geometries for the convective section of a typical process heater.
- Convert mathematical and physical modeling results into design specifications for fabricating a bench-scale unit of dimpled tubes.
- Develop, fabricate, install and test a bench-scale unit at GTI's Combustion Laboratory.
- Construct, install and field-evaluate a pilot-scale convective section comprised of dimpled tubes.
- Issue final report with evaluation and analysis of pilot-scale test data.

Currently, GTI is in the process of developing and evaluating various dimpled tube configurations and surface profiles. The project is estimated to take two years to complete.

Commercialization

A field demonstration will be conducted, with industry partners, under industrial operating conditions at an actual plant site. Licensing arrangements will allow for industry-wide marketing.

Project Partners

Gas Technology Institute
Des Plaines, IL

BP
Naperville, IL

ExxonMobil
Fairfax, VA

For additional information, please contact:

David Salem
Office of Industrial Technologies
Phone: (202) 586-8710
Fax: (202) 586-3237
david.salem@ee.doe.gov

Please send any comments, questions, or suggestions to
webmaster.oit@ee.doe.gov

Visit our home page at
www.oit.doe.gov/chemicals

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

OIT

November 2001